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Population dynamics and ecology of Xanthium albinum

Botanikertagung Braunschweig 2004: Neophyten und Biodiversität

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Population dynamics and ecology of Xanthium albinum

Dietmar Brandes (TU Braunschweig)
&
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Xanthium albinum (Asteraceae)

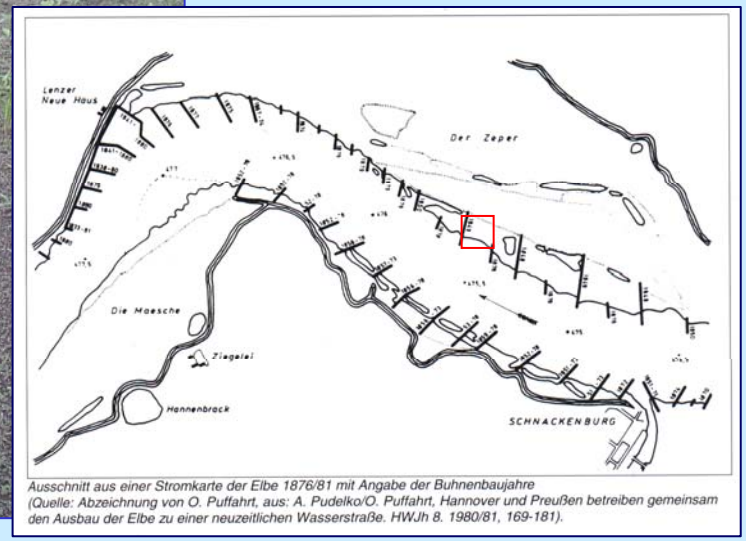
- The genus Xanthium (cocklebur) comprises several related species in the temperate world. Their taxonomy is still confusing.

- Xanthium albinum differentiated from Xanthium saccharatum after its introduction to Europe.

- Xanthium albinum is a short-lived annual growing at riverbanks especially in the river system of the Elbe.

•It was first found at the banks of the river Netze (Poland) in 1830.

Zonation of the vegetation



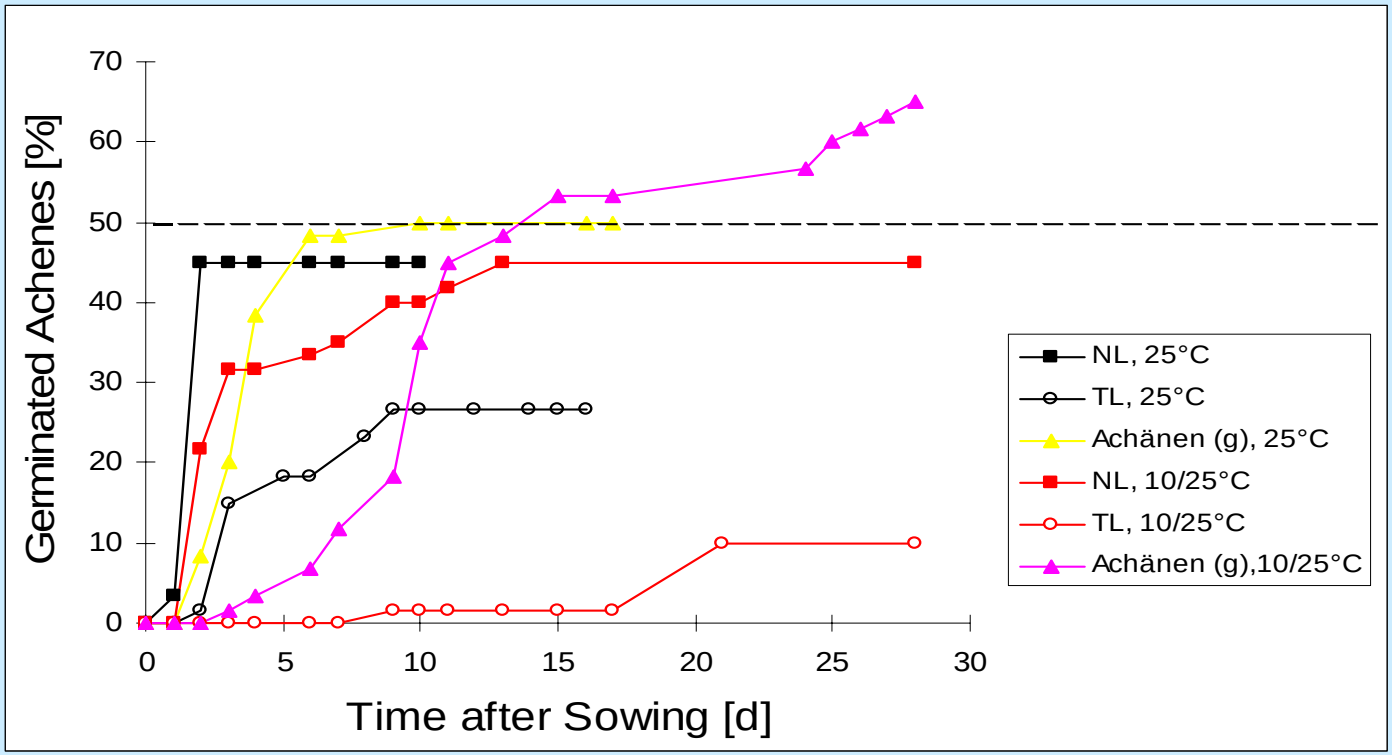
Ausschnitt aus einer Stromkarte der Elbe 1876/81 mit Angabe der Buhnenbaujahre (Quelle: Abzeichnung von O. Puffahrt, aus: A. Pudelko/O. Puffahrt, Hannover und Preußen betreiben gemeinsam den Ausbau der Elbe zu einer neuzeitlichen Wasserstraße. HWJh 8. 1980/81, 169-181).

Groyne field of the middle course of the river Elbe at Lenzen.

Germination of Xanthium albinum: the seedlings emerge immediately if the water level goes down.

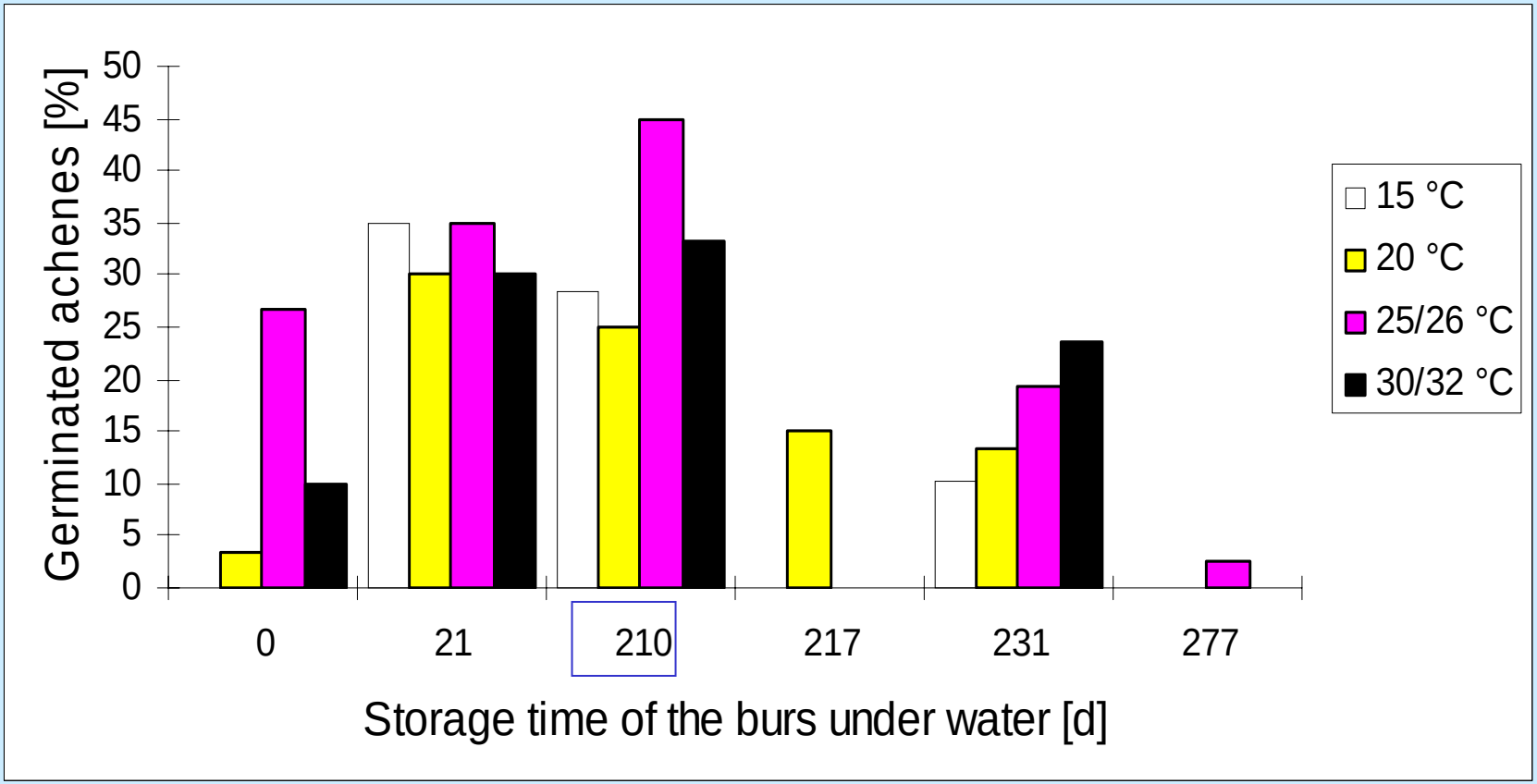
Germination

- Xanthium albinum is a warmth-germinator
- Usually only one achene per bur germinates



NL: storage under water; TL: dry storage; g: both achenes separated.

Germination



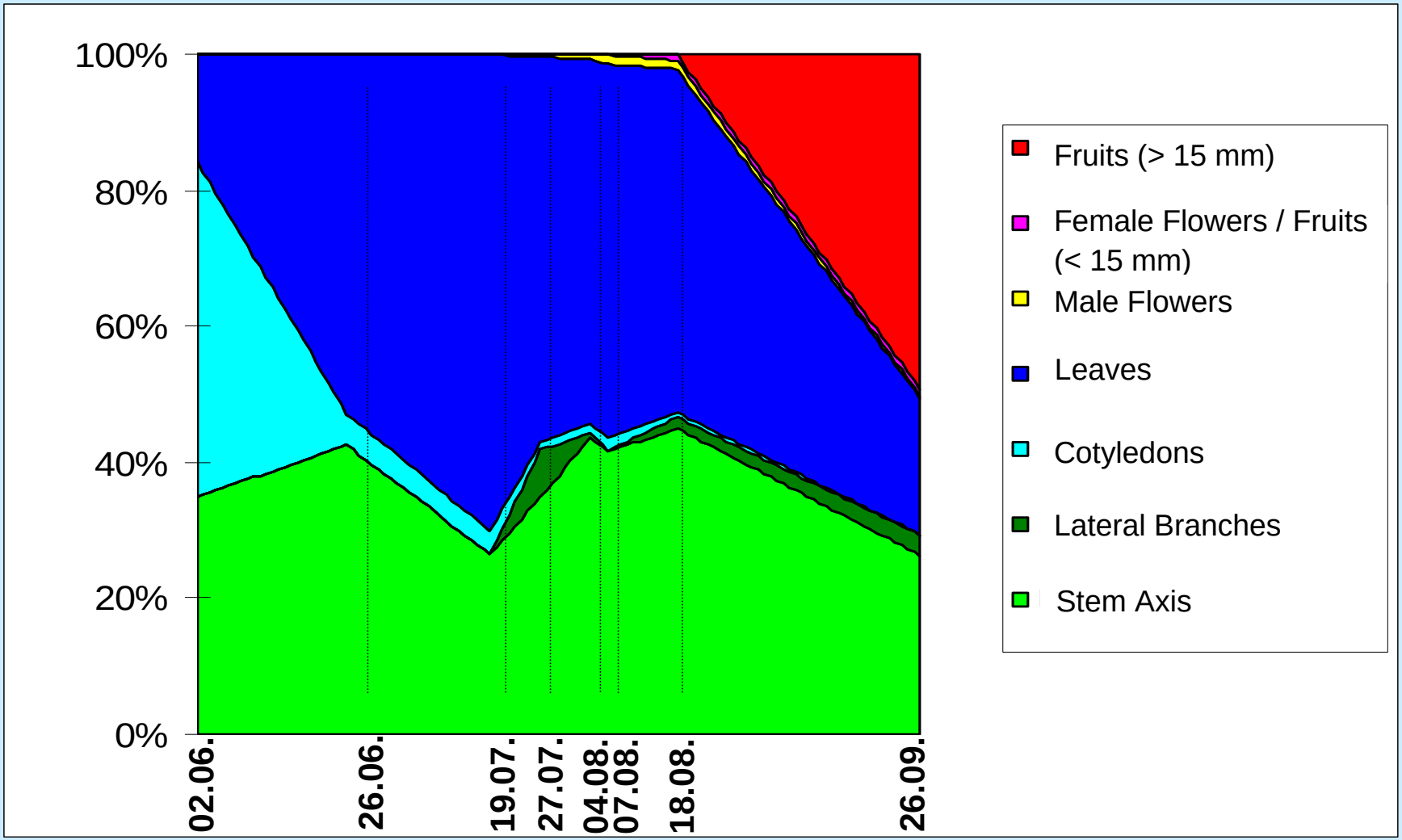
Most burs have to hibernate under water.

Germination depends on storage time of the burs under water.

Growth and development

- The aboveground biomass correlates with the mean growth height (R = + 0,99) in stands dominated by Xanthium albinum.
- The aboveground biomass could be remarkably high (maximum: 885 g/m²).
- Xanthium albinum is a short-day plant.
- The flowering induction occurs at a dark period of 7.5 h, however influenced by temperature and age of the plants.
- Xanthium albinum is self-fertil.

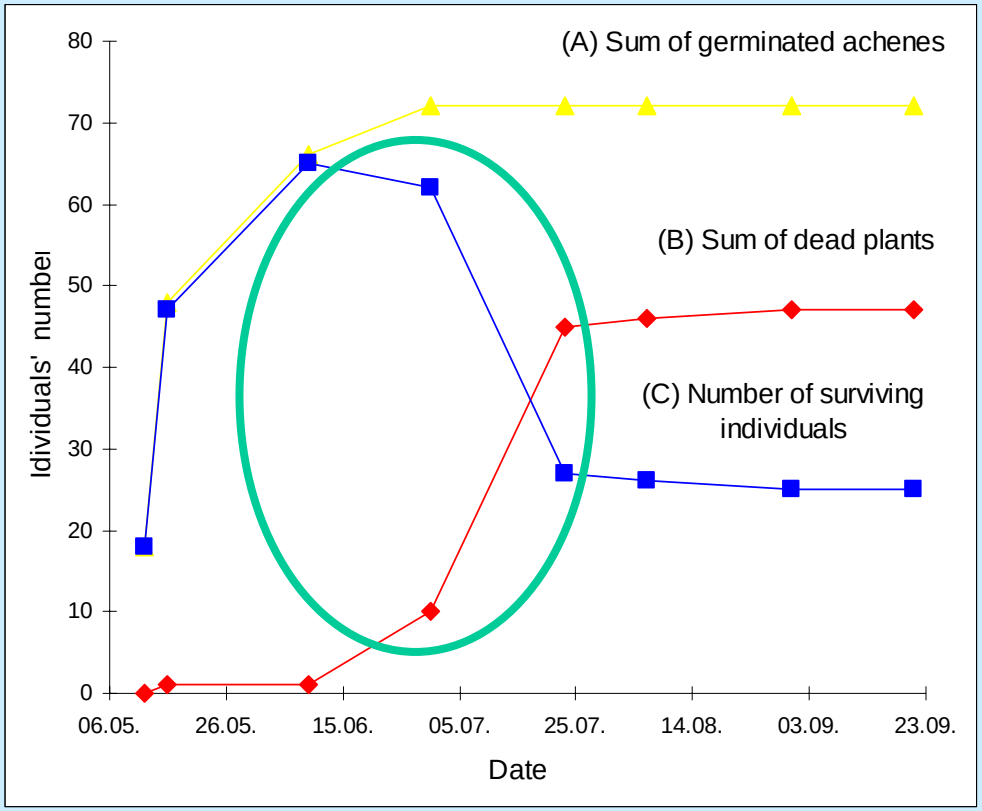
Biomass distribution during a vegetation period



Mortality

- Mortality is of fundamental importance for the population dynamics as well as for the germination.
- The infraspecific competition is of low importance with respect to the mortality of the seedlings of Xanthium albinum.
- Larger embryos have larger resources and therefore possibly adventage in competition, because the length of the cotyledons reflects the size of the achenes.
- No difference was detected between the length of the cotyledons of surviving and dead plants.

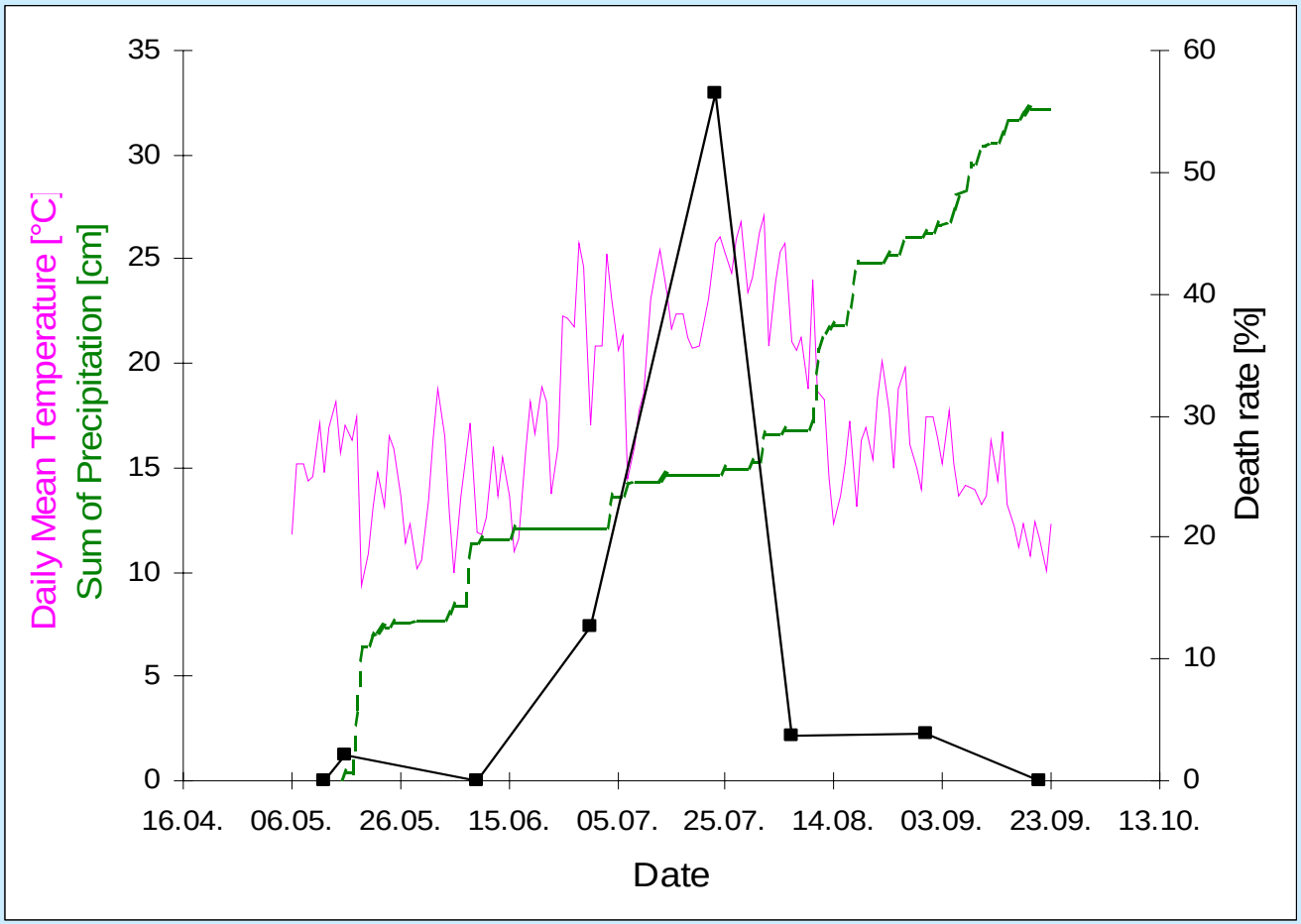
Mortality



Dynamics of a population: sum of germinated achenes (A), sum of dead plants (B), and the number of living indivuals (C).

Permanent plot 1: 72 germinated induviduals, area 42 m²

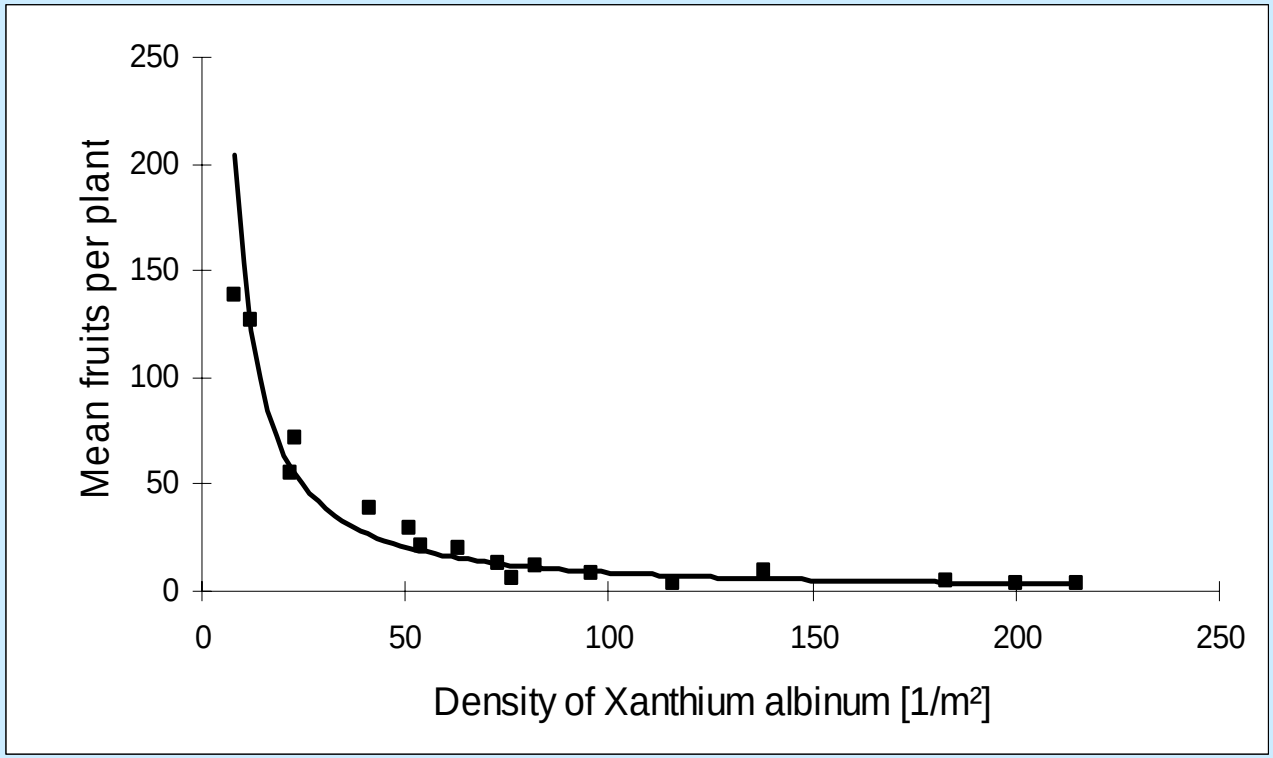
Mortality



Correlation between death rate and weather variation (same plot).

Intraspecific competition

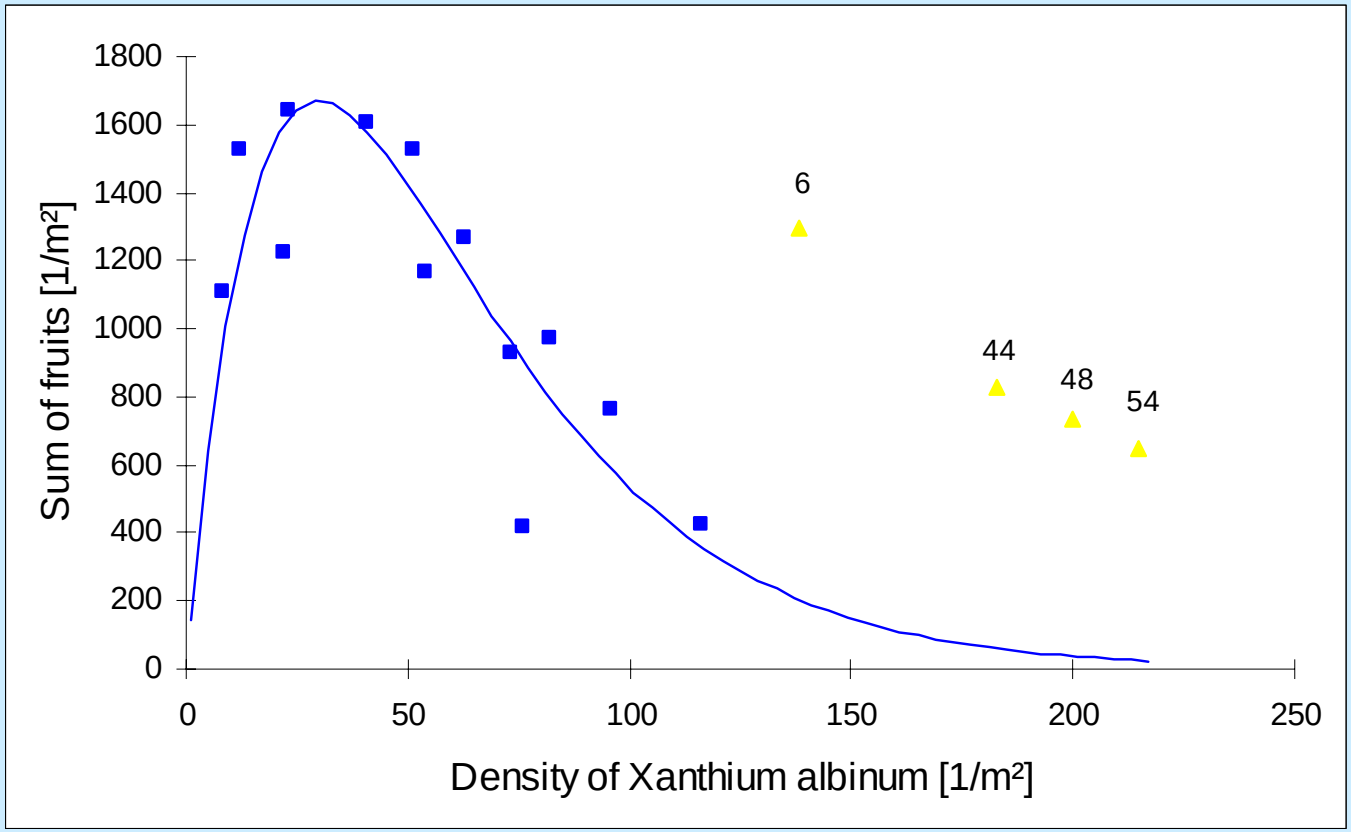
Density-yield relationships and reproductive allocation



Increasing plant density reduces the number of burs per plant.

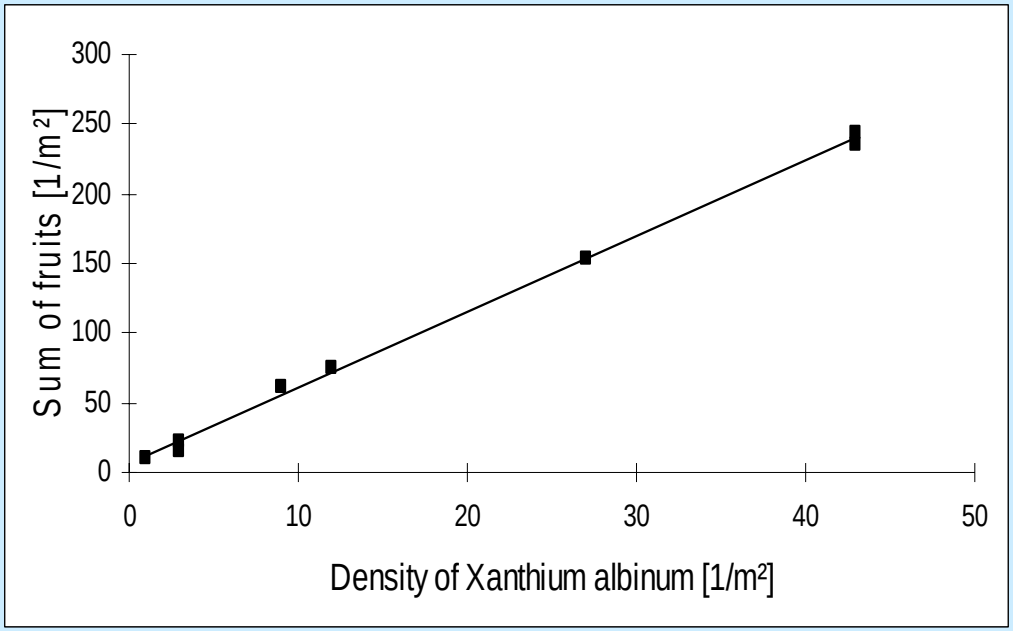
Intraspecific competition

Density-yield relationships and reproductive allocation



If the density exceeds 43 plants/m², the production of burs per m² also decreases rapidly.

Interspecific competition: Influence of Phalaris arundinacea on the production of diaspores



Phalaris arundinacea is the most frequent companion.
8 plots having a cover of Phalaris arundinacea of at least 60 %.

Strong linear correlation between low densities of Xanthium albinum and sum of burs; R = + 0,99.

Interactions with Herbivores

- Slugs
- Mice
- Cattle
  (Cow, Sheep, Horse)

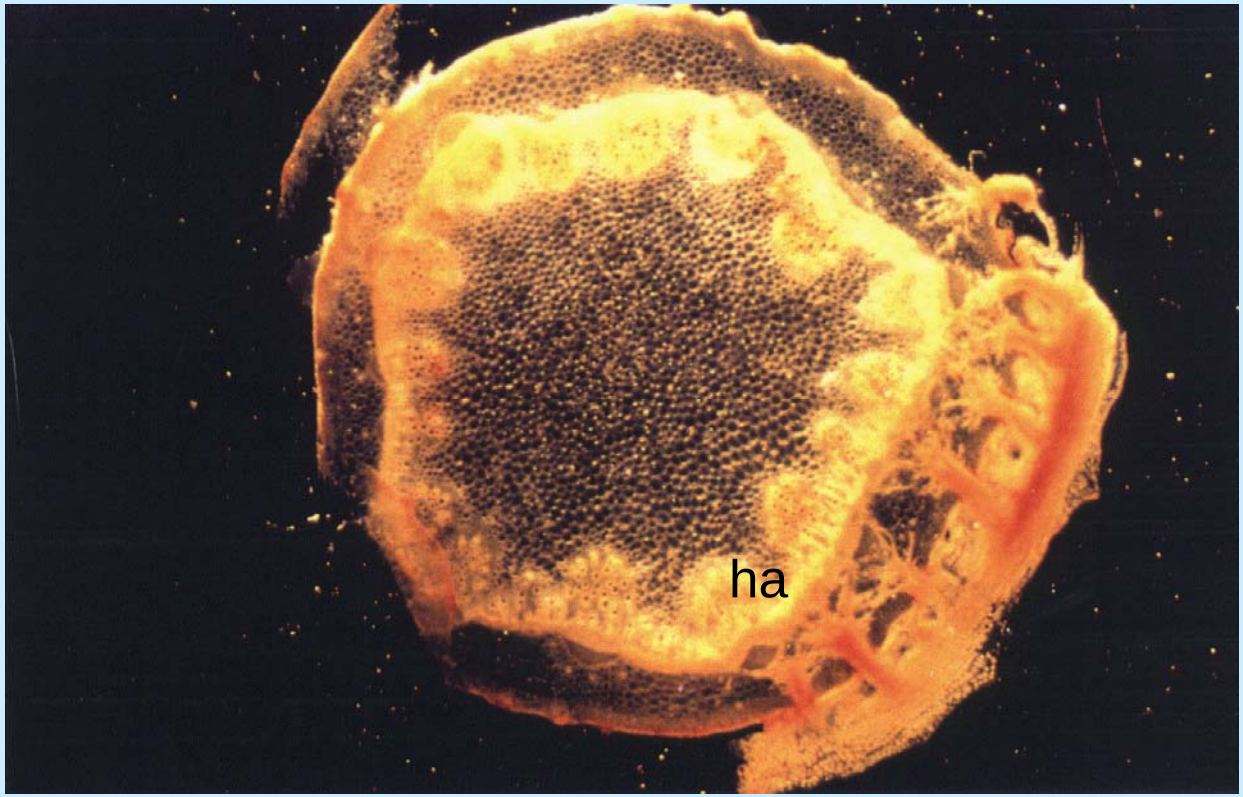
- The seedlings are toxic for animals (Cole et al. 1980)

Grazing by sheep near Brambach: Xanthium albinum is only affected moderately.

Interactions with parasites

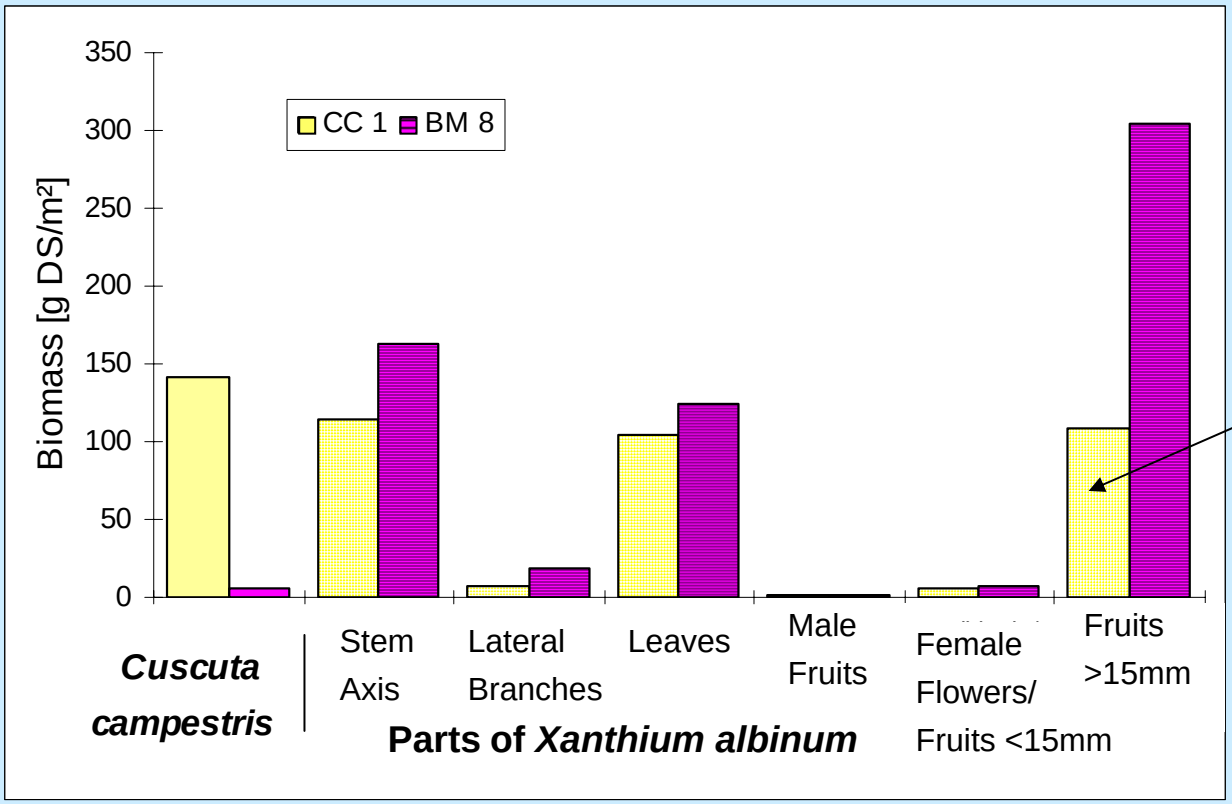
Xanthium albinum parasitised by Cuscuta campestris.

Interactions with Cuscuta campestris



Cross section of the stem of Xanthium albinum with haustoria (ha) of Cuscuta campestris.

Parasitism by Cuscuta campestris



Comparison of the two plots CC1 and BM8:

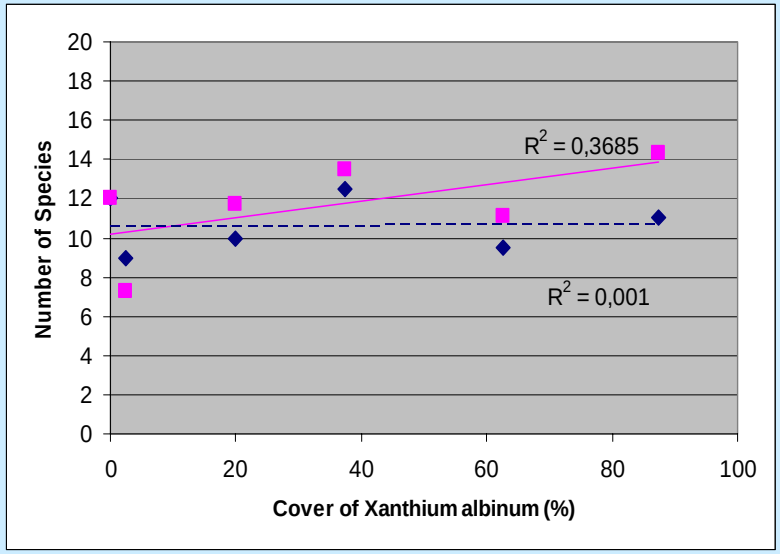
CC1: 1 m², cover of Xanthium albinum 70 %, total biomass 578 g/m²
BM8: 1 m², cover of Xanthium albinum 80 %, total biomass 739 g/m²

Conclusions

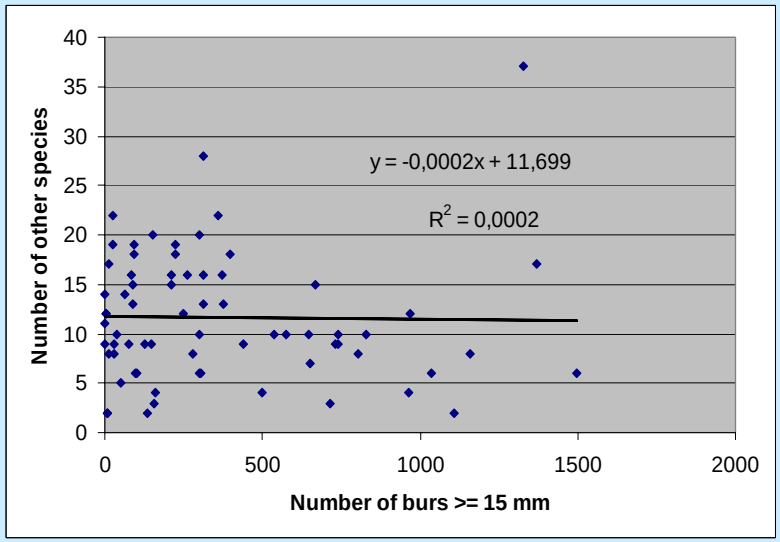
- Xanthium albinum is able to realize a very special niche, which is partly not realized by indigenous species. It invades short-lived nitrophilous riverside communities (Chenopodion fluviatile) and also some communities of Bidention.
- Xanthium albinum needs large rivers with pluvial regime (low water in summer and autumn) and sandy river banks.
- The consolidation of the inland waterway system with groynes obviously facilitates its establishing.
- Xanthium albinum passes very rarely the dikes.
- Xanthium albinum shows no trend to become weedy till now.

Displacement of native species?

There is no influence of the cover of Xanthium albinum on the phytodiversity (number of companion species) of the 70 plots of 1m². (Median and mean).

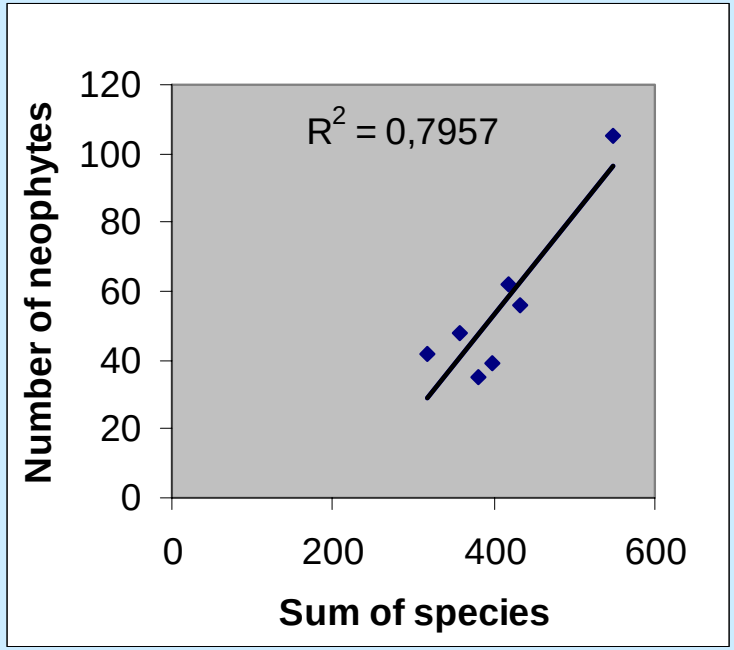


We also found no correlation between vitality of Xanthium albinum (burs/m²) and phytodiversity!



Neophytes vs. phytodiversity of riverbanks

- We found a **positive correlation** between the number of neophytes (post-1492 aliens) and the number of all species for 7 rivers fully investigated in Germany.
- **Our hypothesis**: Species-rich habitats are in a higher degree invaded by alien species than species-poor habitats. (There are no differences between neophytes and indigenous species in principle).
- Our results support the idea of Klotz (2000).



Rivers: Oker, Schunter, Wabe, Ilse, Weser, Rur*, Saar**.

*Kasperek 1996,**Ludewig 1999.